KULIKOV, G.V.

Quaternary sediments of northern Fergana as aquifiers. Uzb. geol. zhur. no.2:35-41 '61. (MIRA 14:5)

1. Institut gidrogeologii i inzhenernoy geologii AN UzSSR,
(Fergana--Water, Underground)

KULIKOV, G. V

56-2-8/47

AUTHOR IVANOVSKAYA, I.A., KULIKOV, G.V., RAKOBOLSKAYA, I.V. SARYCHEVA, L.I.

TITLE Cloud Chamber Investigation of the Electron-Photon Component of Extensive Air Showers at Sea Level (Issledovaniye elektronno-fotonnoy komponenty shirokikh atmosfernykh livney na urovne morya pri pomoshchi kamery Vilsona. Russian)

PERIODICAL Zhurnal Eksperim. i Teoret. Fiziki 1957, Vol 33, Nr 2 (8), pp 358 - 364 (U.S.S.R.)

ABSTRACT By means of a Wilson chamber located at sea level the energy spectrum of the electron-photon component of a broad atmospheric shower with different numbers of particles and different axis spacings was investigated. A dependence of energy spectra of the number of particles in broad showers was not observed. In a large distance from the shower axis the energy spectrum becomes "softer". The experimentally found share of high-energy electrons in different axial spacings cannot be brought into line with the number computed by means of the cascade theory.

For an axial spacing of 2 - 1o m the spatial distribution of the energy flow, of the electron-photon component of the shower can be approximated by the law r^{-n}. n = 2,0 $\pm$ 0,5.

Card 1/2 (With 2 tables, 5 illustrations, and 8 Slavic references).

56-2-8/47

Cloud Chamber Investigation of the Electron-Photon Component of Extensive Air Showers at Sea Level

ASSOCIATION: Institute of Physics im. P.N. Lebedev of the Academy of Sciences of the USSR and Moscow State University (Fizicheskiy institut imeni P.N. Lebedeva Akademii nauk SSSR, Moskovskiy gosudarstvennyy universitet)

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21(0)

AUTHORS: Kulikov, G. V., Khristiansen, G. B. SOV/56-35-3-11/61

TITLE: On the Spectrum of Extensive Atmospheric Showers Corresponding to the Number of Particles (O spektre shirokikh atmosfernykh livney po chislu chastits)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1958, Vol 35, Nr 3, pp 635 - 640 (USSR)

ABSTRACT: In the present paper the authors describe the experimental results concerning the distribution of air showers with respect to the number of particles; investigations were carried out in May 1954 on sea-level. They concerned showers with a total number of 2.10^4 - 2.10^5 particles. The hodoscope- arrangement of counters used is schematically shown by figure 1 and is described in the following. The electronic computer of the computation center of MGU (Moscow State University) was available for the purpose of solving mathematical problems. The measuring space was divided into 3 concentrically arranged ranges:

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1) central range, circular in shape, $S_1=78m^2$ (for $N > 8.10^4$); $S_2=400m^2$, quadratic (for $N > 1,6.10^5$) and $S_3=576m^2$, also quadratic (for still larger N)(Probability of recording > 95%). Figure 2 shows the results obtained by this work as well as those of reference 7 ($10^6 < N < 10^8$) in form of a diagram in double logarithmic scale. It shows the connection between the number of showers F (with a number of particles > N) with N. (F[$cm^{-2}sec^{-1}steradian^{-1}$]). For the range $10^5 \lesssim N \lesssim 10^6$ the following was found: Number of particles N in the shower

	$0,8.10^5$	$1,6.10^5$	$3,2.10^5$	$6,4.10^5$	$8,0.10^5$	$12,8.10^5$
Number of showers with number of particles > N	157	276	138	46	24	6

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The results show that in the case of numbers of particles

On the Spectrum of Extensive Atmospheric Showers Corresponding to the Number of Particles SOV/56-35-3-11/61

varying in range between 10^6 and 10^7 the probability for the occurrence of an irregularity in the shower size distribution curve is very great. Theoretical deliberations seem to show that for cosmic rays with energies $> 10^{16}$eV a galactic or metagalactic origin may be assumed. In conclusion the authors thank Professor S.N.Vernov for his valuable advice and discussions, G.S.Roslyakov for supervising work at the computation center of MGU, and V.I.Solov'yeva and D.S.Stel'makh for their cooperation. There are 2 figures, 1 table, and 12 references, 8 of which are Soviet.

ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University)

SUBMITTED: April 22, 1958

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KULIKOV, G. V.

A STUDY OF THE SPATIAL DISTRIBUTION FUNCTION OF ELECTRONS AND THE DENSITY OF ENERGY FLUX OF THE ELECTRON-PHOTON COMPONENT IN EXTENSIVE AIR SHOWERS

N.N. Goryunov, V.A. Dmitriyev, G.V. Kulikov, Yu. A. Nechin, G.B. Khristiansen

1. The spatial distribution of density of energy fluxes of the electron-photon component was determined from transition curves in lead obtained for different distances from the shower axis; the spatial distribution of particle fluxes was obtained by the method of correlated hodoscopes.

2. The spatial distribution of the density of energy flux of the electron-photon component was obtained up to r = 60 m from the shower axis in extensive air showers with the total number of particles $N = 10^4 - 2 \times 10^6$. The form of the function is independent of the strength of the shower and, if we approximate this function by a power law of the type r^{-n}, we obtain

$n = 1.2 \pm 0.2$	$0.3\ \text{m} < r < 1\ \text{m}$
$n = 1.5 \pm 0.2$	$1\ \text{m} < r < 10\ \text{m}$
$n = 2.0 \pm 0.3$	$10\ \text{m} < r < 60\ \text{m}$

Report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959

KULIKOV, G. V.

GENERAL DESCRIPTION OF THE MOSCOW UNIVERSITY ARRANGEMENT FOR THE STUDY OF EXTENSIVE AIR SHOWERS AND PRELIMINARY RESULTS OBTAINED BY IT

S.N. Vernov, G.B. Khristiansen, A.T. Abrosimov, N.N. Goryunov, V.A. Dmitriev, G.V. Kulikov, Yu.A. Nechin, S.P. Sokolov, V.I. Soloveva, K.I. Soloviev, Z.S. Strugalsky, B.A. Khrenov

1. In late 1957, at the Moscow State University an arrangement was put into operation for multipurpose studies of extensive air showers of cosmic rays.

2. The arrangement is a complex assembly of simulaneously operating physical instruments (some 5000 Geiger-Muller counters covering an area of over 100 m^2, and some 150 ionization chambers of various shapes covering a total area of 13 m^2, and a diffusion chamber of area 0.64 m2) and appropriate electronic equipment and photographic devices to record the instrument readings when an extensive air shower passes through the arrangement. Most of this equipment is located in a specially erected building. Three rooms of theis building (-60 sq.m. in area each) have a light roofing of not more than 1.5 g/cm2 and two rooms (25 m^2 and 80 m2) are situated underground at a depth corresponding to 20 and 40 metres water equivalent.

report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959.

Kulikov, G. V.

SEA-LEVEL STUDIES OF THE HIGH-ENERGY NUCLEAR-ACTIVE COMPONENT OF EXTENSIVE AIR SHOWERS

S. N. Vernov, N. N. Goryunov, V. A. Dmitriyev, G. B. Kulikov, Yu. A. Nechin, G. B. Kristiansen

1. High-energy nuclear-active particles were detected by large bursts produced in ionization chambers by these nuclear-active particles during passage through a composite filter of lead and graphite. The use of a composite filter permits firstly, of separating, in the best possible fashion, the ionization produced in the chambers by the electron-photon component (which appears in the filter due to nuclear-active particles) from the ionization created by the electron-photon component of the shower coming from the air. On the other hand, the use of such a filter gives rise to a situation when the ionization in the chambers turns out to be proportional to the total energy transferred from the nuclear-active particle to the electron-photon component in the filter. So, the energy of a nuclear-active particle can be determined from the burst in the ionization chamber on the basis of rather general considerations.

Report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959

G.V. Kulikov

THE SPECTRUM OF EXTENSIVE AIR SHOWERS ACCORDING TO THE NUMBER OF PARTICLES: THE COEFFICIENT OF ABSORTION OF EXTENSIVE AIR SHOWERS

G.V. Kulikov, N.M. Nesterova, S.I. Nikolsky, G.B. Khristeansen, A.E. Chudakov

1. Utilizing the method of correlated hodoscopes, which permits determining the position of the axis and the number of particles in a shower, we have obtained data on shower spectra level and at sea level.

2. At 3860 m above sea level and the the interval of particle-number variation in the shower from 3×10^4 to 10^7, thespectrum is well approximated by power law $N^{-\chi}$, where $\chi = 1.6 \pm 0.1$. At sea level there is a greater probability that the spectrum will be irregular in the range $10^6 < N < 10^7$ (for $10^4 < N < 10^6$ $\chi = 2.1 \pm 0.2$, and for $N < 10^7$ $\chi = 1.5 - 0.2$.

3. The shower absorption coefficient obtained from a comparison of absolute number of showers with a number of particles greater than that given at mountain altitude and at sea level, amounts to $\mu = 1/(160 - 20)$ g/cm^2.

Report presented at the International Cosmic Ray Conference, Moscow, 6-11 July 1959

31522
S/627/60/002/000/004/027
D299/D304

3.2410 (1559, 2205, 2705)

AUTHORS: Kulikov, G. V., Nesterova, N. M., Nikol'skiy, S. I., Solov"yeva, V. I., Khristiansen, G. B., and Chudakov, A.Ye.

TITLE: Number spectrum of extensive air showers at altitudes of 200 and 3860 m above sea level

SOURCE: International Conference on Cosmic Radiation. Moscow, 1959. Trudy. v. 2. Shirokiye atmosfernyye livni i kaskadnyye protsessy, 87-91

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TEXT: Number spectra of extensive air showers were investigated in detail at the Physics Institute of the AS USSR and at Moscow State University. The spectra were investigated at an altitude of 3860 m and at sea level. Those at sea level were studied over a range $N = 4\cdot10^3$ to $3\cdot10^7$. For showers with small N (10^3 to $5\cdot10^4$), the statistical method was used. The apparatus incorporated hodoscoped Geiger-Müller counters, whose disposition is shown in a figure. The experiments yielded the number of anti-coincidences n per unit time

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for counters of different σ; (σ varied between 0.4 and $1.65 \cdot 10^{-2} m^2$). By comparing the measurements and the calculations, the integral spectrum of the showers was obtained: $F(>N) = 2.5 \cdot 10^{-3} N^{-(1.45 \pm 0.03)}$ $cm^{-2} sec^{-1}$, with $N = 4 \cdot 10^3$ to 10^5. For large N, the spectrum was obtained by individual study of the showers, at sea level. For this purpose, the majority of the counters were disposed in a circle. The position of the axis and the number of particles in each shower were determined by means of the electronic computer "Strela". Thereupon the integral spectrum was found for $N = 8 \cdot 10^4$ to $8 \cdot 10^5$, viz. 4

$$F(>N,0) = (1,95 \pm 0,14) \cdot 10^{-10} \left(\frac{N}{10^5}\right)^{-1,5 \pm 0,1} cm^{-2} sec^{-1} sterad^{-1}$$

Both series of measurements coincide in the range $N \approx 10^5$. In order to determine the absolute number of extensive air showers in the range $N \geqslant 10^7$, the apparatus was divided into 4 groups of counters. Further, extensive air showers were studied at an altitude of 3860 m. The apparatus was controlled by photomultipliers, recording the Cherenkov radiation [Abstractor's note: See article on p. 47, this Trudy.]. The shower axis and the number of particles were determined by means of a simulator. Showers with $N = 2 \cdot 10^4$ to 10^7 were investigated. From the obtained results, the integral spectrum of showers with $N = 2.5 \cdot 10^4$ to $1.3 \cdot 10^7$ was constructed, viz.

$$F(>N,0) = (4,6 \pm 1,4) \cdot 10^{-11} \left(\frac{N}{10^6}\right)^{-(1,60 \pm 0,15)} \text{cm}^{-2}\text{sec}^{-1}\text{sterad}^{-1}$$

The absorption length λ of showers was also determined; for showers with $N\ 10^5$, $\lambda = 156 \pm 22$ gm/cm^2. There are 4 figures and 2 Soviet-bloc references.

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S/627/60/002/000/004/027
D299/D304

Number spectrum of ...

ASSOCIATION: Fizicheskiy institut im. P. N. Lebedeva AN SSSR (Physics Institute im. P. N. Lebedev AS USSR); Nauchno-issledovatels'kiy institut yadernoy fiziki MGU (Scientific Research Institute of Nuclear Physics Moscow State University)

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KULIKOV, G.V.

31526

3,2410 (1559,2205,1705)

S/627/60/002/000/008/027
D299/D305

(4)

AUTHORS: Vernov, S. N., Goryunov, N. N., Dmitriyev, V. A., Kulikov, G. V., Nechin, Yu. A., Solov"yeva, V. I., Strugal'skiy, Z.S., and Khristiansen, G. B.

TITLE: Study of lateral-distribution function of charged particles and of the energy density of the electron-photon component of extensive air showers

SOURCE: International Conference on Cosmic Radiation. Moscow, 1959. Trudy. v. 2. Shirokiye atmosfernyye livni i kaskadnyye protsessy, 117-122

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TEXT: The data obtained by means of the diffusion chamber and the hodoscoped counters permit determining the particle distribution in the neighborhood of the shower axis as well as at large distances from it. These data can be used for determining the number of particles and the position of the axis to an accuracy of approximately 1 m by means of the hodoscoped counters, and to an accuracy of several centimeters if the axis lies within the limits of the diffu-

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Study of lateral-distribution ... D299/D305

sion chamber. The electron-photon component at large distances from the axis was studied by means of large ionization chambers, shielded with lead. During 1000 hours of operation, 28 cases were recorded of the axis (of showers with number of particles $N \geqslant 10^5$) passing through the core detector. All these showers were investigated in detail with respect to distribution and energy of particles. The cases most favorable for analysis are those, in which the shower axis lies in the diffusion chamber. In all, 7 such cases were recorded. For each of these showers, the lateral-distribution function of particle density was constructed for distances ranging from 5 cm to 1 m from the shower axis. It was found that the form of the distribution function varied from shower to shower in the core region. In that region, a peculiar feature of particle distribution was observed, namely a narrow beam (4 cm in diameter) of particles, consisting of a large number (4 to 15) of particles with collinear tracks. From data obtained by means of the hodoscoped counters and knowing the position of the shower axis, it is possible to construct the distribution function of charged particles up to a distance of r = 25 m. from the axis, for each individual

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Study of lateral-distribution ... S/627/60/002/000/008/027
D299/D305

shower. Then the experimental distribution functions were compared with the theoretical functions of Nishimura and Kamata. The results of the comparison are shown in a table. A difference was noted in the form of the distribution of the energy flux of the electron-photon component in the individual shower at a distance of $r \sim 1$ m, and at large distances from the axis; this is due to local fluctuations in the form of the energy distribution in the core. In each of the investigated showers, the energy flux of the electron-photon component was found within a radius of 25 m; it turned out that the electron-photon component energy-flux was stronger (on the average) in showers with small s, than in showers with large s (s being the "age parameter"). The system of counters permitted recording showers with number of particles $N = 10^4$ to 10^7. The data yielded by the diffusion chamber were used for constructing the distribution function for distances $r < 1$ m from the shower axis. The conclusion was reached that the form of the electron-photon energy distribution-function does not depend on the number of particles in the shower. Therefore, all the data were referred to a shower with same N, and the average energy-density distribu-

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tion constructed. Approximating this distribution by a power law of type r^{-n}, one obtains for the exponent n the following values (as a function of the distance r from the axis):

$$n = 1{,}2 \pm 0{,}2, \qquad 0{,}1 < r < 1 \text{ m}$$

$$n = 1{,}5 \pm 0{,}2, \qquad 1 < r < 10 \text{ m}$$

$$n = 2{,}0 \pm 0{,}3, \qquad 10 < r < 60 \text{ m}$$

$$n = 2{,}6 \pm 0{,}2, \qquad 60 < r < 1000 \text{ m}$$

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Further, the mean energy per electron was obtained from experimental and theoretical values (based on the cascade shower theory) of the mean energy as a function of r showed a discrepancy which can be removed by taking into account the effect of nuclear scattering. The experimental values permit calculating the energy of the

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electron-photon component, viz. $E_{eph} = 2.5 \beta N$, where β denotes the mean energy loss per unit of depth t. There are 2 figures, 1 table and 6 references: 5 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publication reads as follows: J. Nishimura, K. Kamata. Suppl. Theor. Phys., no. 6, 1958.

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KULIKOV, G.V.

(2)

31527
S/627/60/002/000/009/027
D299/D305

3,2410(1559,2705,2805)

AUTHORS: Vernov, S. N., Goryunov, N. N., Dmitriyev, V. A., Kulikov, G. V., Nechin, Yu. A., and Khristiansen, G. B.

TITLE: Study of high-energy nuclearactive component of extensive air showers at sea level

SOURCE: International Conference on Cosmic Radiation. Moscow, 1959, Trudy. v. 2. Shirokiye atmosfernyye livni i kaskadnyye protsessy, 123-131

TEXT: The high-energy nuclearactive component was studied by the apparatus of Moscow State University. The nuclearactive component was detected and measured by means of hodoscoped counters and ionization chambers. The processed hodoscope data permitted determining the total number of particles N and the distance R_1 of the shower axis from the ionization chambers. Part of the data were processed by the electronic computer of Moscow State University; thereby the number of particles was determined to an accuracy of approximately 4

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Study of high-energy ...

20%, and the position of the axis to within 0.25 m, provided it fell inside the area of a detector of 4 m^2. The joint processing of the data of the hodoscope and ionization chambers yielded the mean energy of the nuclearactive component of showers of various number of particles, the energy spectra of the nuclearactive particles in the central part of the shower, the lateral distribution of the energy flux carried by the nuclearactive component in the central part of the shower and the lateral distribution of the nuclearactive particles. Showers, whose axes were at a distance of less than 10 m from the detector of nuclearactive particles, were selected for further study. These showers were divided into 4 groups according to number of particles; over 1000 such showers were investigated. The integral spectra of nuclearactive particles of energies $E_{na} \leqslant 10^{12}$ ev. were obtained for the 4 groups. The integral spectra of nuclearactive particles, averaged over the showers of all the groups, can be approximated by an exponential function with exponent $\gamma' = -1.0 \pm 0.2$. For showers with large N (group 4), the value of γ' shows a decreasing tendency. The space distribution of the energy flux near the

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Study of high-energy ...

axis can be approximated by an exponential function with exponent $n = -1.5 + 0.2$. A typical correlation was established between the electron-photon and the nuclearactive components of cores of the individual showers, namely showers with an electron-photon component of an energy much higher than the average, have (as a rule) a nuclearactive component of lesser energy. The converse was also observed. The measurements gave direct evidence of the presence of nuclearactive particles of high-energy ($\sim 10^{12}$ ev.) in showers at sea level, and of the considerable importance of the nuclearactive component in the energy balance of the shower. The nuclearactive component in the central part of the shower carries an energy which is (on the average) almost as large as the entire energy of the electron-photon component at the level of observation. The presence of considerable energy in the nuclearactive component affects the absorption of particles in the shower. The development of individual showers can differ considerably, as the magnitude of the energy of the nuclearactive component differs considerably in the individual showers. The main contribution to the energy flux carried by the nu-

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Study of high-energy ...

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clearactive component within a circle of given radius is made by high-energy particles, whose lateral distribution is such that, on the average, all the particles with energy $\geqslant 10^{12}$ ev. are contained in a circle of radius r = 1 m. The distribution of the energy flux carried by the nuclearactive component showed that this flux is fairly widely distributed. Further, the transverse momentum imparted to the particles (during their generation), was estimated. The nuclearactive component of showers with $N = 10^4$ to 10^6 at sea level carries an energy of 0.5 to 1.0 of the total energy, carried by the electron-photon component. As a result of the energy fluctuations of the nuclearactive component in the individual showers, the development of the showers fluctuates, too. The distribution of the energy flux of the nuclearactive component over a region of $1 \leqslant r \leqslant 20$ m near the axis is described by the law $r^{-2\pm 0.25}$; such a distribution should affect the characteristics of the soft component. There are 4 figures, 1 table and 10 references: 9 Soviet-bloc and 1 non-Soviet-bloc. The reference to the English-language publication reads as follows: J. Nishimura, K. Kamanta.Suppl. Prog.Phys.,no.6, 1958.

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21(7) SOV/56-36-3-4/71

AUTHORS: Vernov, S. N., Goryunov, N. N., Zatsepin, G. T., Kulikov, G.V., Nechin, Yu. A., Strugal'skiy, Z. S., Khristiansen, G. B.

TITLE: Investigation of the Core of Extensive Atmospheric Showers (Issledovaniye stvola shirokogo atmosfernogo livnya)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 3, pp 669-681 (USSR)

ABSTRACT: The group of research scientists followed a suggestion made by D. V. Skobel'tsyn to investigate the passage of extensive atmospheric showers through matter simultaneously in different depths; in this connection an investigation of the shower core was carried out. Figure 1 shows a block scheme of the experimental arrangement used, which furnished data concerning the electron-photon and the nuclear-active components of the shower core. The experimental system consisted essentially of a diffusion chamber ($0.64\ m^2$), 124 ionization chambers in hodoscope-connection, special filters and 672 Geiger-Mueller (Geyger, Myuller) hodoscope counters of different sizes. The method, which is described as new, is described in detail,

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and the possibilities it offers are discussed. The entire device remained in operation for 1300 hours and recorded more than 10,000 passages of extensive air showers. Within 1,000 hours 28 passages of shower cores with a shower particle number of $N > 10^5$ through the first row of ionization chambers were recorded. Figure 4 shows a photograph of the diffusion chamber for such a passage and the corresponding pulse oscillogram of 64 ionization chambers. The article gives numerous individual data concerning different showers as e.g. the ionization distribution in the 64 ionization chambers of the first and second row respectively for $N = 5.10^5$, $1.3.10^5$ and $N \approx 10^5$ with a spatial distribution of energy flux $\sim 1/r^3$ (Fig 6). Figure 8 shows the same, expressed by the number of relativistic particles passing through the ionization chambers of the first and second row for $N = 10^4$ and 2.10^4 and an energy flux $\sim 1/r^2$ and $\sim 1/r$. Figures 6 and 8 show the particle flux distribution in the diffusion chamber for $N = 2.10^6$ and $3.5.10^4$ respectively. In extensive air

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showers with $N > 10^5$ it was observed in the shower core ($r < 1m$) that the total energy of nuclear-active particles is of the order of the energy of the electron-photon component at the same distance from the axis; for individual showers, however, the ratio of these energies showed different values. The energy current density of the electron-photon component shows an increase of up to $r = 20 \div 30$ cm from the shower axis; the course of energy flux density in dependence on r cannot be represented by a general formula. It fluctuates between $\sim 1/r$ and $\sim 1/r^3$. The energy fluxes of electron-photon and nuclear-active components of the shower core show considerable fluctuations (up to 10 times). The authors finally thank Academician D. V. Skobel'tsyn for his help and interest, V. V. Borisoglebskiy for his collaboration, Professor N. A. Dobrotin for his help and discussions, and further also a group of collaborators of the NIU: A. T. Abrosimov, S. S. Glagolevskiy, B. V. Subbotin, A. D. Yerlykin, A. B. Kamnev, E. N. Sosnov for their help in carrying out experiments. There are 9 figures, 2 tables, and 12 references, 11 of which are Soviet.

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ASSOCIATION: Moskovskiy gosudarstvennyy universitet (Moscow State University) Fizicheskiy institut im. P. N. Lebedeva Akademii nauk SSSR (Physics Institute imeni P. N. Lebedev of the Academy of Sciences, USSR)

SUBMITTED: July 21, 1958

Kulikov, G. V.

21(7) SOV/56-36-3-16/71

AUTHORS: Abrosimov, A. T., Dmitriyev, V. A., Kulikov, G. V., Massal'skiy, Ye. I., Solov'yev, K. I., Khristiansen, G. B.

TITLE: The Nuclear-Active Component of High Energy in Extensive Atmospheric Showers at Sea Level (Yaderno-aktivnaya komponenta vysokoy energii v shirokikh atmosfernykh livnyakh na urovne morya)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 3, pp 751-761 (USSR)

ABSTRACT: In the present paper the authors report about statistical investigations of nuclear avalanches in extensive air showers at sea level by means of a sensitive detector. Measurements were carried out in 1957 by means of a device for combined investigations of extensive air showers which is now in operation at the MGU. It has 4 cylindrical pulse ionization chambers under a lead-graphite filter and 720 Geiger-Mueller (Geyger-Myuller) counters in hodoscope connection for the recording and energy determination of nuclear particles. The counters were connected in coincidence groups (total area 1320 cm²), so that sixfold coinciding pulses were recorded. Figure 1 gives a rough outline of the device including its dimensions.

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The Nuclear-Active Component of High Energy in Extensive Atmospheric Showers at Sea Level

The recorded and investigated showers are divided into 4 groups according to the particle number N:

1) $1.10^4 \leqslant N_1 < 3.10^4$; 2) $3.10^4 \leqslant N_2 < 1.10^5$;

3) $1.10^5 < N_3 < 3.10^5$; 4) $3.10^5 \leqslant N_4 < 2.10^6$.

For these 4 groups table 1 gives the number of particles with energies greater than one given, and also the maximum energy of the nuclear-active particle of individual groups. For the latter the following applies:

group	R	E^{max}_{nucl}	γ
1	3m	$4.7.10^{12}$ev	1.8 ± 0.3
2	4m	10^{13}ev	1.0 ± 0.2
3	5m	$1.8.10^{13}$ev	0.9 ± 0.3
4	6m	6.10^{13}ev	0.7 ± 0.3

(R = radius of the investigated shower range)

Figure 2 shows the course of the spectrum for the two extreme groups. Further investigations deal with the spatial distribution of the energy flux of the nuclear-active component;

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The Nuclear-Active Component of High Energy in Extensive Atmospheric Showers at Sea Level

figure 6 shows such a diagram for 4 shower groups with particle energies of $1.10^{11} - 3.10^{11}$ev, $3.10^{11} - 1.10^{12}$, $\geqslant 1.10^{12}$ and $E > 8.10^{11}$ev. Figure 4 shows the course of energy flux density for N_1, N_3 and N_4, and figure 5 shows the distribution of the energy flux in a shower with $N = 2.10^5$. It was found that the energy of the nuclear-active component in some showers with equal N may differ considerably. Results are discussed, and in an appendix the energy distribution with respect to primary particles is investigated. The authors finally thank S. N. Vernov, G. T. Zatsepin for their help, valuable remarks, and discussions. They further thank S. V. Bogoslovskiy, V. I. Artemkin, and V. N. Sokolov for taking part in measurements. There are 6 figures, 2 tables, and 17 references, 15 of which are Soviet.

ASSOCIATION: Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta (Institute for Nuclear Physics of Moscow State University)

SUBMITTED: September 15, 1958

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21(1) SOV/56-36-4-2/70

AUTHORS: Vernov, S. N., Babetskiy, Ya. S., Goryunov, N. N., Kulikov, G. V., Nechin, Yu. A., Strugal'skiy, Z. S., Khristiansen, G. B.

TITLE: On the Structure of the Core and the Central Regions of Extensive Atmospheric Showers at Sea Level (O strukture stvola i tsentral'-nykh oblastey shirokikh atmosfernykh livney na urovne morya)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 4, pp 976-984 (USSR)

ABSTRACT: The object of the present paper was an experimental investigation of the spatial distribution of the energy flux of the electron-photon and the nuclear-active component in the core and the central regions of extensive air showers; the present paper is a continuation of an article published in the preceding issue of this periodical (Ref 1), in which the method and the experimental arrangement were already described. Figure 1 is a schematical representation of the chamber system with the distribution of hodoscope counters. The counters were located in groups of 12 and 24 in containers. The ionization chambers had a total area of 4 m^2. In the course of the 1800 hours during which the apparatus was in operation, about 18000

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SOV/56-36-4-2/70

On the Structure of the Core and the Central Regions of Extensive Atmospheric Showers at Sea Level

showers were recorded, with particle numbers of between 10^3 and 10^6, and axes which were at a distance of up to 30 m from the system of ionization chambers. From the manifold material obtained by these investigations the spatial distribution obtained for individual showers or groups of showers (classification according to particle number N) are analyzed. For spatial particle flux density it holds that $\varrho(r) \approx 2.10^{-3}N/r$ for $r < 10$ m, for the energy flux density: $\varrho_E(r) \sim r^{-n}$. For shower groups of different sizes (ΔN from $1.0.10^5 - 5.0.10^5$ up to $5.10^3 - 5.10^5$) table 1 shows how many of the total of 82 investigated showers correspond to certain n-values (from < 0.8 to 3.2 - 3.4). Figure 2 (a,b) shows the spatial distribution of the energy flux of electron-photon and nuclear-active components of two different shower groups, figure 3 shows the energy spectrum of the nuclear-active component in the shower cores, and figure 4 shows the distribution of the absolute values of the energy flux of the electron-photon component in a circle with the radius 1.5 m round the axis of a shower with $\overline{N} \approx 10^5$ particles.

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The diagram is characteristic of the strong oscillations observed. Figure 5 finally shows the spatial energy flux distribution within the range of from 0.1 to 30 m; the measured values (in a semilogarithmic diagram) are practically on a steeply declining straight line. Thus, the following is obtained for the electron-photon component:

$$\varrho_{e-ph} \sim 1/r^{1.35} \quad \text{at} \quad 0.1\ \text{m} < r < 2.0\ \text{m}$$

$$\varrho_{e-ph} \sim 1/r^{2} \quad \text{at} \quad 2.0\ \text{m} < r < 30\ \text{m}$$

and for the nuclear-active component: $\varrho_{n-a} \sim 1/r^2$ at $0.2\text{m} < r < 30\text{m}$.

Figure 6 again shows the spatial distribution of the absolute values of energy flux in a distance of 10 m from the shower core; like within the range of the core itself, oscillations are considerable. The authors finally thank G. T.Zatsepin and I. P. Ivanenko for advice and discussions. There are 6 figures, 3 tables, and 3 Soviet references.

ASSOCIATION: Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta (Institute for Nuclear Physics of Moscow State University)

21(8) SOV/56-36-4-4/70

AUTHORS: Dmitriyev, V. A., Kulikov, G. V., Massal'skiy, Ye. I., Khristiansen, G. B.

TITLE: The Spatial Distribution of the Energy Flux of the Electron-Photon Component of Extensive Atmospheric Showers (Prostranstvennoye raspredeleniye potoka energii elektronno-fotonnoy komponenty shirokikh atmosfernykh livney)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 4, pp 992-1000 (USSR)

ABSTRACT: In the present paper the authors report on the results obtained by measurements carried out between June 1957 and February 1958 at sea level by means of a device for the complex investigation of extensive air showers. The device is at present in operation at MGU (Moscow State University). It is described in detail and is illustrated by figure 1 in form of a schematical drawing. The ionization chambers used had a diameter of 25 cm and a length of 1 m, the total area covered by them amounting to 3 m^2; they were filled with very pure argon, pressure 3 atm, and were enclosed on all sides by filters. The counters, each of 330, 100, and 18 cm^2, were arranged in groups of 24 and were

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The Spatial Distribution of the Energy Flux of the Electron-Photon Component of Extensive Atmospheric Showers

arranged in such a manner that they operated simultaneously within a range of distances of 1 - 50 m from the shower axis. A total of 2000 Geiger-Mueller counters in hodoscope connection (GK-7) was used. Showers with particle numbers of from 1.10^4 to 2.10^6 were investigated. The showers were divided into groups with the average particle numbers $< 1.10^4$, 2.10^4, $5.6.10^4$, 2.10^5, $5.7.10^5$ and $> 10^6$ for the 6 N_i-groups. For energy flux density it holds that $\varrho_E = n(t)\int_0^t \beta dt$ and for $t = 8$ $\varrho_E = \int_0^{t=8} n(t)\beta dt + \int_0^\infty \beta n(t=8)\exp(-\omega_t t)dt$ (Figure 2 shows the course of these curves for the N_4-group). $n(t)$ denotes the particle number in dependence on the penetration depth t, and β denotes the average energy loss per t-unit. Figure 3 in semilogarithmic scale shows the course of energy flux density for the groups $N_1 - N_5$. Further diagrams show the dependence of electron-photon component energy on the distance from the shower axis r

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SOV/56-36-4-4/70

The Spatial Distribution of the Energy Flux of the Electron-Photon Component of Extensive Atmospheric Showers

and on N. Further data concern investigations of the meson component. For $r < 6$ m it holds that

$N_{\mu} = 10^{-2} \int \frac{kN}{r} 2\pi r dr = 7.3 \cdot 10^{-4} N$, $(k = 2 \cdot 10^{-3}) \Delta E_{\mu} (< 6m) \sim$ $0.005\ E_{el-ph} (< 6m)$ for the share of the muon component in energy flux. For the electron-photon component the following holds for n: $n = -1.5 \pm 0.2$ at $1m < r < 8m$ and

$n = -2.0 \pm 0.3$ at $10m < r < 50m$.

The spatial energy distribution function of this component does not depend on N for showers with the total particle number of $N = 10^4 - 10^6$. The spatial distribution of the energy fluxes in the central part of the shower agrees with the cascade theory calculations in the case of a cascade parameter $s = 1.2$ being used. It was further found that with an increase of distance from the shower axis the energy flux of the electron-photon component decreases more slowly than the energy flux of the nuclear-active component. In a circle with the radius

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SOV/56-36-4-4/70

The Spatial Distribution of the Energy Flux of the Electron-Photon Component of Extensive Atmospheric Showers

of 50 m about 75% of the total energy of the electron-photon component of the shower is contained. The authors finally thank S. N. Vernov and G. T. Zatsepin for their great help, I. P. Ivanenko for discussions, and V. I. Artemkin, L. A. Dikarev, V. N. Sokolov, K. I. Solov'yev, and D. S. Stel'makh for assisting in measurements and in the evaluation of data. There are 5 figures and 13 references, 9 of which are Soviet.

ASSOCIATION: Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta (Institute for Nuclear Physics of Moscow State University)

SUBMITTED: September 15, 1958

Card 4/4

DMITRIYEV, V.A.; KULIKOV, G.V.; KHRISTIANSEN, G.B.

Investigation of high-energy nuclear-active particles at sea level. Zhur.eksp.i teor.fiz. 37 no.4:893-905 O '59. (MIRA 13:5)

1. Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta.
(Cosmic rays)

VERNOV, S.N.; GORYUNOV, N.N.; DMITRIYEV, V.A.; KULIKOV, G.V.; NECHIN, Yu.A.; KHRISTIANSEN, G.B.

Function of the spatial distribution of a flux of charged particles in an individual extensive air shower. Zhur. eksp. i teor. fiz. 38 no.1:297-298 Jan '60. (MIRA 14:9)

1. Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta.

(Cosmic rays)

S/056/60/039/002/042/044
B006/B070

AUTHORS: Vernov, S. N., Ivanenko, I. P., Kulikov, G. V., Khristiansen, G. B.

TITLE: The Nature of the Particle Beams 19 in the Core of an Extensive Air Shower /9

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 2(8), pp. 509 - 512

TEXT: In an earlier paper (Ref. 1) the authors communicated their investigations of a shower core by means of diffusion chamber. They found that narrow beams consisting of 4-15 particles appear, and the beam trajectories are collinear. These particle beams are, either, cores of electron-photon avalanches released from π^{0}-mesons, or groups of high-energy muons. Which of these alternatives is correct, is now investigated. In the present paper, the authors show that the latter is much more probable. The first assumption is discussed in detail, and the experiment and its results are analyzed from this stand-point. The observed number of particles in the beam can only be released by primary particles whose

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The Nature of the Particle Beams in the Core of an Extensive Air Shower

S/056/60/039/002/042/044
B006/B070

energy $E_0 \geqslant 10^{12}$ ev. The energy spectrum of electrons and photons in the avalanche at a depth of 2t-units had the following form (N - number of particles released by particles with $E_0 = 10^{12}$ ev):

E	10^8	10^9	10^{10}	10^{11}
$N_{el}(>E)$	5.5	4.0	2.5	0.5
$N_{phot}(>E)$	10	8.0	4.0	0.8

For their experiments, the authors used a plate of lead glass (type ТФ-1 (TF-1)) with high lead content. This plate covered one half of the diffusion chamber. 850 hours of measurement were made in the open chamber and 440 hours in the closed one. The actual number of particles observed in the showers is much smaller than that which would be expected if the first assumption on the nature of the collinear beam were true. Experiments performed with diffusion chamber, arranged above two rows of ionization chambers, gave similar results. The second assumption, that the observed beam consists of μ-mesons, is then briefly discussed. For

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The Nature of the Particle Beams in the Core of an Extensive Air Shower

S/056/60/039/002/042/044
B006/B070

$E_{\mu} = 10^{13}$ ev, a value 0.3 per muon is obtained for the probability of electron-positron pair production in the filter of lead+graphite (~ 10 t-units over the second row of ionization chambers). The number of particles in the avalanche cores recorded in the second row of chambers, (Φ_{ex}) in ΔE, agrees with the number of pair production calculated from muons (Φ_{th}):

ΔE ev	2.10^9	$2.10^9 - 2.10^{10}$	2.10^{10}
Φ_{ex}	39	7	2
Φ_{th}	40	5	3

Also the absence of multiplication on the passage of the beam through 0.8 t-units of lead glass agrees with the assumption that a high-energy muon beam is concerned. The authors thank L. G. Smolenskiy and B. A. Zelenov for help in the experiments and S. F. Semenko for help in the calculations. There are 1 table and 5 Soviet references.

ASSOCIATION: Institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta (Institute of Nuclear Physics of the Moscow State University)

SUBMITTED: June 20, 1960

Card 3/3

KULIKOV, G. V., SOLOVYEVA, V. I., KHRISTIANSEN, G. B., BELYAYEVA, J. F.,

ATRASHKEVICH, V. J., DMITRIYEV, V. A., ABROSIMOV, A. T., NECHIN, YU. A., KHRENOV, B. A.,

"The Structure of Extensive Air Showers at Sea Level."

report submitted for the Intl. Conf. on Cosmic Rays and Earth Storm (IUPAP)
Kyoto, Japan 4-15 Sept. 1961.

KULIKOV, G.V.

4

37550

S/048/62/026/005/014/022
B102/B104

3.2410 (2205, 2705, 2805)

AUTHORS: Vernov, S. N., Khristiansen, G. B., Belyayeva, I. F., Dmitriyev, V. A., Kulikov, G. V., Nechin, Yu. A., Solov'yeva, V. I., and Khrenov, B. A.

TITLE: The primary cosmic-ray component at superhigh energies and some peculiarities of its interaction with nuclei of air atoms

PERIODICAL: Akademiya nauk SSSR. Izvestiya. Seriya fizicheskaya, v. 26, no. 5, 1962, 651-657

TEXT: The paper is a report on experiments with the Moscow University large apparatus (area $4\cdot10^4$ m^2) for comprehensive studies of extensive air showers induced by high-energy cosmic particles. The charged-particle detectors (Geiger counters in hodoscope arrangement) cover an area of 110 m^2, the muon detectors (2-3 counter layers shielded with lead and iron, in hodoscope arrangement) more than 12 m^2, 6.3 m^2 of which are under

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40 m water equivalent. The nuclear-active-particle detectors form a system of 128 ionization chambers (8 m^2) shielded by lead and graphite filters. The number of muons produced in charged-pion decay was estimated (the pions were assumed to be formed in gamma-quantum photoeffect on nuclei of air atoms): $N_\mu^\Gamma(E) \leqslant \sigma_0 E_0/1.6(1-\alpha)E$, $\alpha \leqslant 0.5$, $\sigma_0 < 10^{-3}$; for $E_0 \sim 10^{16}$ ev and $E_\mu = 10^{10}$ ev ($\alpha = 0.5$), $N_\mu^\Gamma(10^{10}) \leqslant 10^5$. The number N_μ^n of muons in nuclear showers was measured. For showers with $N = 7\cdot10^6$ a mean number of $8\cdot10^4$ muons with $E \geqslant 10^{10}$ ev is to be expected. The spatial muon flux distribution was determined for these two types of showers (ρ_μ^n and ρ_μ^Γ). In the case of a simple model of air shower production (Suppl. Nuovo Cimento, 2, 649, 1958), an analysis of the experimental data yields $N = k_e E_0 \exp(-x+x_m+x_0)/\Lambda$; E_0 is the energy of the primary particle, x_0 is the depth of its first interaction, $x_m = B\log E_0$ (x - depth of observation), N is the total number of

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shower particles; the number of muons $N_\mu = k_\mu E_0^\alpha$; $\Lambda = 200$ g/cm^2, $B = 30$ g/cm^2 and $\alpha = 0.8 \pm 0.1$. If the primary energy spectrum has the shape $AE_0^{-(\gamma+1)}dE_0$, at fixed N the N_μ distribution has the shape $N_\mu^{1/\alpha\left(\frac{\Lambda+B}{\lambda}-\gamma-1\right)}dN_\mu$, λ being the mean free path with respect to interaction. Comparison between experiment and theory yields $\lambda = (85\pm5)$ g/cm^2, as an upper limit. For charged muons their energies (E_μ) and numbers (n_π) were measured and calculated for several altitudes H; W is the probability for a charged pion produced at H decays without interacting with an air nucleus. The results indicate that in ~ 3% of all cases nuclear interaction is accompanied by a production of narrow beams of great numbers of charged pions. There are 8 figures.

+

NSEN, G. B.; ABROSIMOV, A. M.; KHRENOV, B. A.; ATRASHKEVICH, V. B.;
G. V.; SOLOVIYEVA, V.I.; FOMIN, Yu. A.

The cosmic ray primary radiation of ultra high energy.

Report submitted for the 8th Intl. Conf. on Cosmic Rays (IUPAP), Jaipur, India,
2-14 Dec 1963

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R000927420009-8"

S. ..; KHRISTIANSEN, G. B.; ABROSIMOV, A. M.; KHRENOV, DMITRIYEV, V. A.
..., V. I.; SOLOVYEV, K.I.; BELYAYEVA, M.F.; NECHIN, Yu. A.; VEDENEYEV, O.N.;
..., G. V.; FOMIN, Yu. A.

S...ry of the new data on EAS structure obtained with the aid of the complex
e...pment of Moscow State University.

...ort submitted foe the 8th Intl. Conf. on Cosmic Rays (IUPAP) Jaipur, India,
...-14 Doc 1963

APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R000927420009-8"

L 40709-65 EWO(j)/EWT(m)/FCC/T IJP(c)

ACCESSION NR: AP5012318

UR/0048/64/028/011/1886/1893

AUTHOR: Vernov, S. N.; Khristiansen, G. B.; Abrosimov, A. T.; Belyayeva, I. F.; Dmitriyev, V. A.; Kulikov, G. V.; Nechin, Yu. A.; Solov'yeva, V. I.; Khrenov, B.A.

TITLE: New data on the study of broad atmospheric showers using a complex apparatus /Report of All-Union Meeting on Cosmic Rays Physics, held in Moscow from October 4 to 10, 1963/

SOURCE: AN SSSR. Izvestiya. Seriya fizicheskaya, v. 28, no. 11, 1964, 1886-1893

TOPIC TAGS: cosmic ray shower, nuclear particle, nuclear physics apparatus

ABSTRACT: Experiments are described that were conducted at Moscow State University on a complex apparatus for the study of broad atmospheric showers and the mu-meson component of cosmic rays. The apparatus gave simultaneous information on the electron-photon, mu-meson, and nuclear-active components of broad atmospheric showers in each individually recorded shower. Orig. art. has: 9 graphs, 3 tables.

ASSOCIATION: Nauchno-issledovatel'skiy institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta im. M. V. Lomonosova (Scientific Research Institute of Nuclear Physics, Moscow State University)

SUBMITTED: 00 ENCL: 00 SUB CODE: AA, NP

NO REF SOV: 003 OTHER: 006 JPRS

Card 1/1

[illegible] [illegible], Yu.A.; [illegible]

[illegible] radiation of superhigh [illegible] [illegible] Ser.
[illegible] no.12:1934-1941 D '64 ([illegible] 18:2)

VERNOV, S.N.; KHRISTIANSEN, G.B.; ABROSIMOV, A.T.; ATRASHKEVICH, V.B.; BELYAYEVA, I.F.; VEDENEYEV, O.V.; DMITRIYEV, V.A.; KULIKOV, G.V.; NECHIN, Yu.A.; SOLOV'YEVA, V.I.; SOLOV'YEV, K.I.; FOMIN, Yu.A.; KHRENOV, B.A.

Description of a modernized complex setup for studying extensive air showers. Izv. AN SSSR Ser. fiz. 28 no.12:2087-2092 D '64

(MIRA 18:2)

L 4528-66 EWT(m)/FCC/T IJP(c)

ACC NR: AP5024632 SOURCE CODE: UR/0048/65/029/009/1676/1681

AUTHOR: Vernov, S.N.; Khristiansen, G.B.; Abrosimov, A.T.; Atrashkevich, V.B.; Belyayeva, I.F.; Vedeneyev, O.V.; Kulikov, G.V.; Fomin, Yu. A.; Nechin, Yu. A.; Solov'yeva, V.I.; Khrenov, B.A.

ORG: none

TITLE: Investigations of fluctuations in the development of extensive air showers with a fixed total number of charged particles and a fixed total number of muons /Report, All-Union Conference on Cosmic Ray Physics held at Apatity 24-31 August 1964/

SOURCE: AN SSSR. Izvestiya. Seriya fizicheskaya, v. 29, no. 9, 1965, 1676-1681

TOPIC TAGS: cosmic ray shower, muon, charged particle, extensive air shower, particle distributic particle distribution

ABSTRACT: The authors have employed the modernized installation at Moscow State University, described elsewhere (S.N.Vernov et al., Izv. AN SSSR Ser. fiz., 28, 2087, 1964), to investigate the simultaneous distribution of total number N of charged particles, total number M of muons, and age parameter S in extensive air showers. Showers were selected for which the zenith angle of the axis was less than 30°. M was determined from the number of muons recorded by the muon detector and the perpendicular distance of the muon detector from the shower axis with the aid of the known lateral distribution of muons. The relative error in determining M did not exceed 35 %. The

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L 4526-66

ACC NR: AP5024632

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error in determining S was estimated to be 0.02 by processing "artificial" showers of known age, calculated by Monte Carlo methods. The data presented were derived from some 300 showers with total numbers of charged particles ranging from 10^5 to 4×10^6. Histograms are given showing the distribution of showers with respect to N with fixed M, with respect to M with fixed N, with respect to S with fixed N, and with respect to S with fixed M, and scatter plots are given for N versus S with fixed M and for M versus S with fixed N. The correlation coefficient of S with M for fixed N ranged between 0.62 and 0.72; the correlation coefficient of S with N for fixed M was - 0.67. Orig. art. has: 10 formulas, 4 figures, and 1 table.

SUB CODE: NP/ SUBM DATE: 00/ ORIG REF: 005/ OTH REF: 001

OC

Card 2/2

L 25772-66 EWT(m)/FCC/T IJP(c)

ACC NR: AP6016380 SOURCE CODE: UR/0048/65/029/010/1876/1880

AUTHOR: Vernov, S. N.; Khristiansen, G. B.; Abrosimov, A. T.; Atrashkevich, V. B.; Belyayeva, I. F.; Kulikov, G. V.; Solov'yeva, V. I.; Fomin, Yu. A.; Khrenov, B. A.

ORG: Scientific Research Institute of Nuclear Physics, Moscow State University im. M. V. Lomonosov (Nauchno-issledovatel'skiy institut yadernoy fiziki Moskovskogo gosudarstvennogo universiteta) 40 B

TITLE: Primary superhigh-energy cosmic radiation according to data on extensive atmospheric showers 19

SOURCE: AN SSSR. Izvestiya. Seriya fizicheskaya, v. 29, no. 10, 1965, 1876-1880

TOPIC TAGS: cosmic radiation, muon

ABSTRACT: Of interest in the investigation of the primary energy spectrum of cosmic rays and their composition is the knowledge of the spectrum of extensive atmospheric showers (e.a.s.) with respect to the total number N_μ of high energy muons ($E_\mu \geq 10^{10}$ eV) and the distribution of e.a.s. over the total number of the particles N_e for a given N_μ. In this connection the authors analyze the primary energy spectrum of cosmic rays on the basis of experimental data obtained with a special device for investigating e.a.s. recorded with a probability of $W \geq 0.95$. This device makes it possible to determine the total number of charged particles in an e.a.s.

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APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R000927420009-8"

L 25772-66

ACC NR: AP6016380

at the observation level. An averaged function $\rho_\mu(R)$ is plotted to determine the spatial distribution N_μ of the muons, and, thus, the total number of these muons is determined. The distribution of N_e for a given N_μ is evaluated on the basis of data on an e.a.s. with $N_\mu = (1-2)\cdot 10^4$. The experimental findings are found to be in satisfactory agreement with theory. Thus, on the basis of the complex whole of the experimental findings, it may be concluded that the composition of primary cosmic rays in the superhigh-energy region apparently does not significantly differ from the composition in the low-energy region, and the γ-index of the primary energy spectrum is variable rather than constant. Orig. art. has: 5 figures. [JPRS]

SUB CODE: 20, 04 / SUBM DATE: none / ORIG REF: 009 / OTH REF: 002

Card 2/2

L 06994-67 EWT(m) IJP(c)
ACC NR: AP6021527 SOURCE CODE: UR/0089/66/020/006/0509/0510

AUTHOR: Vladimirova, M. V.; Batalov, A. A.; Kulikov, I. A.; Shulyatikova, L. G.

ORG: none

TITLE: New method of chemical dosimetry 19 of reactor radiation 44 B

SOURCE: Atomnaya energiya, v. 20, no. 6, 1966, 509-510

TOPIC TAGS: water cooled nuclear reactor, reactor neutron flux, hydrogen, iron, radiation detector/ VVR reactor

ABSTRACT: This is an abstract of paper no. 85/3450 submitted to the editor and filed, but not published. On the basis of experimental data on the yield of H_2 and Fe^{3+} for different radiators, the authors have established relations between this yield and the linear energy transfer of the recoil γ quanta and protons in mixed fluxes of fast neutrons and γ quanta. The dosimetry procedure described is based on determining, following equal irradiation time in the reactor, the concentration of the hydrogen and trivalent iron in two solutions. One solution is gas-free H_2SO_4 (0.8 N), and the other is the same liquid but saturated with oxygen and mixed with $FeSO_4$. Previously obtained plots of the hydrogen yield against the ratio of the yields and concentrations of H_2 and Fe^{3+} (Atomnaya energiya v. 17, 222, 1964) make it possible to determine the hydrogen yield for the mixed radiation, and then to calculate the absorbed energy and from it finally the rate of oxidation of iron. The procedure was tested for a mixed stream of α particles from Po^{210} and β particles from H^3 and used for

 UDC: 539.12.04

L 06994-67

ACC NR: AP6021527

dosimetric measurements in the channels of the VVR reactor. A formula for the ratio of the γ and neutron doses in the reactor is obtained. The proposed method for determining the absorbed energy in water-cooled reactors can be used for the range $(0.5 - 5) \times 10^5$ rad. Orig. art. has: 2 figures and 3 formulas.

SUB CODE: 18/ SUBM DATE: 02Sep65/ ORIG REF: 002

Card 2/2 ZC

KULIKOV, I.A., Cand Med Sci -- (diss) "On the ~~question~~ problem of the state of the organ of sight in late ~~toxicosis~~ pregnancy toxemia ~~pregnancies~~." Stalingrad, 1958, 14 pp (Stalingrad State Med Inst) 200 copies (KL, 39-58, 112)

ABUSHKEVICH, P.V.; VAYSBRUD, V.I.; KULIKOV, I.A.; LEV, M.I.;
MAZURIN, N.D.; ROZINA-ITSKINA, TS.S.; TIKHONOV, G.I.

Epidemic and etiological nature of the virus influenza epidemic in Khabarovsk in January-March 1959. Vop. virus. 5 no. 6:750 N-D '60. (MIRA 14:4)

(KHABAROVSK--INFLUENZA)

SHARKOVSKIY, I.A., prof.; KULIKOV, I.A., kand.med.nauk; ZHUKOVA, I.V., vrach; MURAV'YEVA, K.A., vrach

Detection of glaucoma among workers of the Stalingrad Tractor Plant and the "Krasnyi Oktiabr'" Metallurgical Plant. (Stalingrad). Vest.oft. no.4:3-4 '61. (MIRA 14:11)

1. Kafedra glaznykh bolezney (zav. - prof. I.A. Sharkovskiy) Stalingradskogo meditsinskogo instituta.
(GLAUCOMA) (VOLGOGRAD--MACHINERY INDUSTRY--HYGIENIC ASPECTS)

ABUSHKEVICH, P.V.; BELYAYEVA, N.S.; KULIKOV, I.A.; [illegible]V, M.I.; MAZURIN, N.D.

Natural tularemia foci in Khabarovsk Territory. Zhur. mikrobiol. epid. i immun. 40 no.5:48-51 My '63. (MIRA 17:6)

L-39091-66 EWT(m)

ACC NR: AP6022880 SOURCE CODE: UR/0186/66/008/002/0226/0232

AUTHOR: Vladimirova, M. V.; Kulikov, I. A.; Shulyatikova, L. G. 45

ORG: none B

TITLE: Alpha- and beta-radiolysis of aqueous solutions of light and heavy water 19

SOURCE: Radiokhimiya, v. 8, no. 2, 1966, 226-232

TOPIC TAGS: alpha radiation, beta radiation, heavy water, radiation effect

ABSTRACT: The effect of various substances on the yield of hydrogen formed under the influence of α radiation (emitted by dissolved polonium) and β radiation (emitted by dissolved tritium) in ordinary and heavy water (D_2O) containing 3×10^{-3} M Fe^{2+} was studied. The criterion of capture of H and D radicals was the value of the initial hydrogen yield. The yields of radical products of radiolysis, obtained from the dependence of the oxidation of iron on the absorbed energy, showed the presence of a considerable isotope effect. The influence of the hydrogen radical acceptors NO_3^-, NO_2^-, and UO_2^{2+} on the hydrogen and deuterium yields in the α and β radiolysis of light water and α radiolysis of heavy water was determined. It was found that the decrease of H_2 yield is different in these two media. This is due to the difference in the radii of the Gaussian distribution of the H and D radicals, and also to the difference in the rate constants of the reactions between the radicals and the acceptors. Orig. art. has: 5 figures, 3 tables, and 9 formulas.

SUB CODE: 07/ SUBM DATE: 23Nov64/ ORIG REF: 005/ OTH REF: 010 UDC: 541.15

Card 1/1 *20/egk*

KULIKOV, I.F.

Device for lifting rotors of the generator of hydroelectric power stations. Sbor.Novo-Kram.mashinostroi.zav. no.1:132-137 '59.(MIRA 16:12)

KULIKOV, I.F.

Testing high-capacity crossbeam. Sbor.Novo-Kram.mashinostroi.zav. no.1:152-160 '59. (MIRA 16:12)

KULIKOV, I.G.; YAKIMOV, S.Ya., red.; PANTELEYEVA, L.A., tekhn. red.

[Safety measures in the production of rubber hose] Tekhnika bezopasnosti v proizvodstve rezinovykh rukavov. Moskva, Goskhimizdat, 1963. 31 p. (MIRA 17:3)

KULIKOV, I.G.; YAKIMOV, S.Ya., red.

[Safety measures in carbon black producing plants] Tekhnika bezopasnosti v tsekhakh po proizvodstvu sazhi. Moskva, Izd-vo "Khimiia," 1964. 37 p. (MIRA 17:5)

DENISOV, Yuriy Stepanovich; KULIKOV, I.G., inzh.-podpolkovnik, red.; KONOVALOVA, Ye.K., tekhn.red.

[Radio engineering in artillery meteorology] Radiotekhnika v artilleriiskoi meteorologii. Moskva, Voen.izd-vo M-va obor. SSSR, 1958. 92 p. (MIRA 12:2)

(Radio meteorology) (Artillery)

KULIKOV, I.G.; BARASHKOV, M.I.; LAPSHINA, A.P., red.; KOGAN, V.V., tekhn. red.

[Safety measures in transportation operations] Tekhnika bezopasnosti pri transportnykh rabotakh. Moskva, Gos. nauchno-tekhn. izd-vo khim. lit-ry, 1961. 23 p. (MIRA 15:5)
(Loading and unloading--Safety measures)

BARASHKOV, M.I.; VOLODIN, A.S.; KULIKOV, I.G.; YAKIMOV, S.Ya., red.; KOGAN, V.V., tekhn. red.

[Safety measures in working with calenders and rubber mixers] Tekhnika bezopasnosti pri rabote na val'tsakh i rezinosmesiteliakh. Moskva, Goskhimizdat, 1962. 26 p. (MIRA 16:3)
(Rubber industry—Safety measures)

8(1) PHASE I BOOK EXPLOITATION SOV/1624

Kulikov, Ivan Georgiyevich

Akkumulyatory (Storage Batteries) Moscow, Voyen. izd-vo M-va oborony SSSR, 1958. 118 p. No. of copies printed not given.

Ed.: N. P. Shiryayev, Captain-Engineer; Tech. Ed.: A. N. Mednikova.

PURPOSE: This book is intended for sergeants and officers operating various radio equipment. It also may be useful to those interested in the structure and operation of various types of storage batteries.

COVERAGE: The book explains in popular form the construction and operation of lead, alkaline and sintered-plate storage batteries. It provides comparison tables and recommends methods of charging, discharging, maintenance and storage. No personalities are mentioned. There are no references.

Card 1/6

TABLE OF CONTENTS:

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Storage Batteries SOV/1624

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APPROVED FOR RELEASE: 08/23/2000 CIA-RDP86-00513R000927420009-8"

KULIKOV, Ivan Georgiyevich; SHIIKAYEV, N.P., inzh.-mayor, red.; MEDNIKOVA, A.N., tekhn. red.

[Storage batteries] Akkumuliatory. Izd.2., ispr. i dop. Moskva, Voen. izd-vo M-va obor. SSSR, 1961. 150 p. (MIRA 14:7)
(Storage batteries)

ALEKSANDROV, Vladimir Nikolayevich; KULIKOV, Ivan Grigor'yevich; NARYSHKIN, A.A., nauchnyy red.; LITVAK, D.S., red.; TOKER, A.M., tekhn.red.

[Tinsmith] Slesar'-zhestianshchik. Moskva, Vses.uchebno-pedagog. izd-vo Proftekhizdat, 1960. 223 p. (MIRA 14:3)

(Tinsmithing)

BARASHKOV, M.I.; KULIKOV, I.G.; YAKIMOV, S.Ya., red.; KOGAN, V.V., tekhn. red.

[Safety measures in the work with assembly machines for automobile tires] Tekhnika bezopasnosti pri rabote na sborochnykh stankakh avtomobil'nykh pokryshek. Moskva, Goskhimizdat, 1962. 22 p. (MIRA 16:6)
(Rubber industry--Safety measures)

SHITOV, A.P.; PYATAKOV, L.L.; GORBUL'SKIY, I.Ya.; KULIKOV, I.M.; KURBAT, S.I.

Induction surface hardening of tractor block bushings instead of through hardening. Prom.energ. 11 no.8:21-22 Ag '56.
(Cast iron--Hardening)

BESSONOV, S.V.; KULIKOV, I.M.

Feasibility of Nerchinsk deposit ore dressing in heavy suspensions. Izv.vys.ucheb.zav.; tsvet.met. 2 no.6:47-51 '59. (MIRA 13:4)

1. Irkutskiy gornometallurgicheskiy institut. Kafedra obogashcheniya poleznykh iskopayemykh.
(Nerchinsk--Ore deposits) (Ore dressing)

GLEMBOTSKIY, V.A.; KULIKOV, I.M.

Effect of calcium and magnesium ions on cerussite sulfidizing and flotation processes. Izv. vys. ucheb. zav.; tsvet. met. 5 no.2:38-44 '62. (MIRA 15:3)

1. Irkutskiy politekhnicheskiy institut, kafedra obogashcheniya poleznykh iskopayemykh.
(Cerussite) (Ore dressing) (Ion exchange)

GLEMBOTSKIY, V.A.; KULIKOV, I.M.

Positive effect of ammonium sulfate on processes of sulfidizing and flotation of cerussite in presence of calcium and magnesium ions. Izv.vys.ucheb.zav.; tsvet.met. 5 no.3:32-41 '62. (MIRA 15:11)

1. Irkutskiy politekhnicheskiy institut, kafedra obogashcheniya poleznykh iskopayemykh.
(Cerussite) (Flotation)

KULIKOV, I. M.

Ways to increase the recovery of lead from Transbaikalia complex metal ores. Trudy Vost. Sib. fil. AN SSSR no.41:46-56 '62. (MIRA 15:10)

1. Irkutskiy politekhnicheskiy institut.

(Transbaikalia—Nonferrous metals)
(Lead ores)

GLEMBOTSKIY, V.A.; KULIKOV, I.M.

Sulfidization of cerussite by means of various sulfidizers and their combinations in the flotation process. Trudy IPI no.20: 27-35 '63. (MIRA 18:2)

KULIKOV, I.M.

Improving the technology of dressing mixed lead-zinc ores of Transbaikalia. Trudy IPI no.20:69-87 '63. (MIRA 18:[illegible]

FULIKOV, I.L., [illegible]YLEVICH, Ya.M., [illegible], [illegible]

Studying the effectiveness of rock breaking by toothed roller bits. Trudy TSNIIPodzemshakhtostroia no.3:59-63 '64.
(MIRA 18:9)

KULIKOV, I.O.

Determining the total hole drilling footage. Trudy TSNIIPodzemshakhstroia no.2:120-123 '63. (MIRA 17:5)

KULIKOV, Igor' Onufriyevich; GUSEV, Nikolay Dmitriyevich; UL'YANINSKIY, Boris Aleksandrovich; FILTSYN, Viktor Grigor'yevich; KAZAKOV, B.Ye., otv. red.

[Mines on Spitsbergen] Shakhty na Shpitsbergene. Moskva, Nedra, 1964. 108 p. (MIRA 18:2)

Theory of [illegible] Solutions. [illegible]
Finkel'shtein, and I. S. Kulikov (*Doklady Akad. Nauk S.S.S.R.*,
[illegible] 81, [illegible] (in Russian). Math. [illegible]

KULIKOV, I. S.

KULIKOV, I. S. -- "Investigation of the Kinetics of Reactions Between Metal and Slag by Means of Radioactive Isotopes." Sub 30 Oct 52, Moscow Order of Labor Red Banner Inst of Steel imeni I. V. Stalin. (Dissertation for the Degree of Candidate in Technical Sciences).

SO: Vechernaya Moskva, January-December 1952

USSR.

Discussion of the V. I. Baptizmanskii paper on "The problem of heat of solution of electrolytes." I. S. Kulikov. *Ukrain. Khim. Zhur.* 19, 455-7(1953); *Referat. Zhur., Khim.* 1954, No. 23248.—A discussion of the equation for the heat of soln. of electrolytes in water (*C.A.* 48, 13598g). Reply to I. S. Kulikov. V. I. Baptizmanskii. *Ukrain. Khim. Zhur.* 19, 457-60(1953); *Referat. Zhur., Khim.* 1954 No. 23249. M. Hosch

Moscow Steel Inst.

Kulikov, I.S.

USSR.

The behavior of sulfur in blast-furnace gases. I. S. Kulikov and L. M. Tsylev. *Izvest. Akad. Nauk S.S.S.R., Otdel. Tekh. Nauk* 1954, No. 12, 102-10.—S in the coke burns to SO_2 inside the blast furnace. The lowering of CO_2 concn. in the gas phase causes a reduction of S, with the formation of CS_2, C, S_2, HS, H_2S, and COS. The max. S, S_2, CS_2, and HS contents are obtained at 1600, 1400, 1250 and 1160°, resp., while H_2S and COS are higher at lower temps. Fe, FeO, and CaO are the most effective absorbents for S, in the order given, and the absorptive efficiency of Fe and FeO becomes lower at higher temp., and is increased for CaO. The absorption of S in Fe is reduced by its liquefaction and satn. with C, and the Fe becomes supersatd. with S at the lower horizons, and gives it up to CaO. At equil. conditions S should be completely eliminated from the gas, and its considerable presence in it proves that equil. is not reached at the high temp., and that S is evolved from the fused slag. Fe_2O_3 and Fe_3O_4 oxidize S to SO_2. $CaCO_3$ absorbs S effectively, and the CaS formed is unaffected by CO and CO_2, but interacts with Fe_3O_4 with the formation of SO_2. The formation of $CaSO_4$ is improbable as long as the partial pressure of SO_2 does not exceed 10^{-4}. S in pyrite and FeS can be oxidized to SO_2, which should not be readsorbed near the furnace throat if the temp. there is above 350-400°. W. M. Sternberg

KULIKOV, I.S., kandidat tekhnicheskikh nauk; ZHUKHOVITSKIY, A.A., professor, doktor khimicheskikh nauk.

Using radioactive tracers to investigate the kinetics of reactions between metal and slag. Sbor.Inst.stali no.32:54-78 '54. (MLRA 10:5)

1.Kafedra fizicheskoy khimii.
(Diffusion)-(Radioactive tracers)

USSR/Engineering - Metallurgy . Kulikov, I. S. FD-2243

Card 1/1 Pub 41-11/17

Author : Kulikov, I. S., Moscow

Title : Some questions on the theory of slag

Periodical : Izv. AN SSSR, Otd. Tekh. Nauk 2, 113-121, Feb 1955

Abstract : Reviews investigations on the activity of slag components in relation to their concentration, on their thermal relationship, and on the partial heat of solution of slag components. Essentially a review of the work of other researchers. Diagrams, formulae, table. Nine references, 6 USSR.

Institution:

Submitted : December 30, 1954

KULIKOV, I. S.

USSR/ Physical Chemistry - Thermodynamics. Thermochemistry. Equilibrium. Physicochemical analysis. Phase transitions B-8

Abs Jour : Referat Zhur - Khimiya, No 4, 1957, 11148

Author : Ivanov L.I., Kulikov I.S., Matveyeva M.P.
Inst : Department of Technical Sciences, Academu of Sciences USSR
Title : Method for Determining Vapor Tension and Diffusion Constants

Orig Pub : Izv. AN SSSR, Otd. tekhn. n., 1955, No 8, 145-147

Abstract : A method has been developed for determining vapor pressure of components and diffusion constants in metal alloys. In a chamber are placed, one above the other, two samples of the same chemical composition one of which contains a radioactive isotope. The samples are placed into ceramic holders which are inserted in Mo-pans. A vacuum (10^{-6} - 10^{-7} mm Hg) is produced in the unit and heating is effected by means of an induction furnace. On heating the apparatus is disconnected from the pumps and a vapor pressure of the components of the alloy, corresponding to the experiment temperature, becomes established therein. A reaction of isotope exchange takes place between the samples, which can be followed by observing the radioactivity increase of the inactive sample. Temperature is measured

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USSR/ Physical Chemistry - Thermodynamics. Thermochemistry. Equilibrium. Physicochemical analysis. Phase transitions B-8

Abs Jour : Referat Zhur - Khimiya, No 4, 1957, 11148

with a Pt - PtRh thermocouple and is regulated within $\pm 3^{\circ}$. To decrease the reverse flow of radioactive atoms the surface area of the inactive sample is made 20-30 times greater than that of the active. Absolute amount of evaporated component is determined, after cooling in vacuum, by comparison with radioactivity of a standard sample. Under the described conditions kinetics of isotope ecchange is determined by the rate of evaporation of the tagged component from the radioactive sample and the velocity of diffusion flow of tagged component from internal layers to the surface of radioactive sample. The inclination angle of the linear portion of $Q = f(t)$ curve (Q --amount of substance evaporated from the active sample) serves to determine the rate of evaporation. A formula for determining the diffusion coefficient has been derived. The method has been checked with technical iron over the temperature range 1120-1255°. A good agreement with literature data has been attained. If the rate of evaporation is high and the curve has no linear portion a diaphragm with a small aperture can be inserted between the samples.

Card 2/2

KULIKOV, I. S., MATVEYEVA, M.P., and IVANOV, L. I.

"On Absorption Methods Used in Investigating Diffusion along the Granular Boundaries of Metals" a paper read at the International Metallurgists' Conference, Moscow 26-30 June 56

SO: CS-3,302,240, 11 Jan 57.

KULIKOV, I. S., MATVEYEVA, M. P., and IVANOV, L. I.

"On Absorption Methods Used in Investigating Diffusion along the Granular Boundaries of Metals" lecture given at the International Metallurgists Conference, Moscow 26-30 June 56

Source CS-3,302,240, 11 Jan 57.

KULIKOV, I. S.

Ivanov, L. I., Matveyeva, M. P., Kulikov, I. S., "Concerning the Question of the Determination of Thermodynamic Constants of Metals and Alloys."

in book Research on Heat Resistant Alloys, pub by Acad. Sci. USSR, Moscow, 1956, 160pp.

Inst. Metallurgy im A. A. Baykov

KULIKOV, Ivan Stepanovich; POPOV, Ivan Alekseyevich; AGEYEV, N.V., redaktor; SMIRNOV, V.F., redaktor; GOLYATKINA, A.G., redaktor; ATTOPOVICH, M.K., tekhnicheskiy redaktor.

[Using radioactive isotopes in metallurgy] Primenenie radioaktinnykh izotopov v metallurgii. Pod nauchnoi red. N.V.Ageeva i V.F.Smirneva. Moskva, Gos. nauchno-tekhn. izd-vo lit-ry po chernoi i tsvetnoi metallurgii, 1956. 260 p. (MIRA 9:6)

1.Chlen-korrespondent AN SSSR (for Ageyev, Smirnov).
(Radioisotopes--Industrial applications) (Metallurgy)